Report for 2001GU1341B: Contaminant and Restoration Assessment of Agana Swamp, and Adjacent Waters

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Report Follows:

PROJECT SYNOPSIS REPORT

Project Title: Contaminant and Restoration Assessment of Agana Swamp, and Adjacent Waters

Problem and Research Objectives

The Agana Swamp is an area of permanent wetland bordering the western shores of central Guam. It is lens fed and also receives surface runoff from the surrounding slopes of Sinajana, to the southwest, and Mongmong, to the northeast. Water is drained from the swamp into the coastal belt via the Agana River. The swamp contains a rich diversity of flora and fauna and is a popular fishing ground for many local people. It also lies adjacent to several high-yielding water wells.

In 1995, PCB contaminated soil was discovered in the vicinity of the Agana Power Plant located at the northern edge of the Agana Swamp. Preliminary studies carried out by the US Navy subsequently revealed relatively high levels of PCBs in fish taken from the swamp and adjacent river system. To data, however, there is no definitive link between PCBs in fish from the swamp and the high levels found at the power plant. Indeed, levels found in fish and sediment samples taken from sites close to the power plant were found to be lower than those taken further away at the headwaters of the Agana River. The discrepancy between the limited data sets therefore implies that the Agana Power Plant may not be the only major source of PCBs into this watershed.

The following study was deigned to determine the distribution and abundance of PCBs and other contaminants (chlorinated pesticides and heavy metals) in surface and subsurface soils from the Agana Swamp and adjacent waters. The study focused primarily on samples taken from the swamp perimeter thus complementing the earlier US Navy data for samples collected from accessible points within it. The objectives of the study were to delineate concentration gradients of the above contaminants within the study area, identify areas of enrichment, and locate primary point sources if they exist. Also, to provide urgently needed baseline data upon which sound watershed restoration strategies could be implemented as necessary.

Methodology

One hundred and twelve soil cores (30 x 5 cm) were collected at ~100-200 m intervals around the perimeter of the wetland (Fig. 1) using stainless steel corers fitted with pre-cleaned aluminum liners. Additionally, 18 cores were taken from the lower reaches of Agana River that exits the swamp and drains into Agana Bay (~1200 m length). A slide hammer was used to push the corers into the substrate at each site. Once charged with soil, the liners were removed from the corers and fitted with Teflon lined, plastic end-caps. They were then wrapped in aluminum foil and immediately chilled for transportation to the laboratory where they were stored at -20^{o}C. Horizontal surface sediment sweeps were also made at eight sub-tidal sites in Agana Bay, immediately adjacent to the Agana River mouth. The samples were collected in hand-held aluminum liners and prepared for transportation and storage in the same way as described above for the soil cores.

When required for analysis, the frozen cores were expelled from the aluminum liners using a heat-gun and gentle pressure from a Teflon rod. The extruded cores were rewrapped in aluminum foil, refrozen, and then cut into two equal lengths using a band saw. The upper and lower sections of each core were thus operationally defined as surface and subsurface samples respectively.

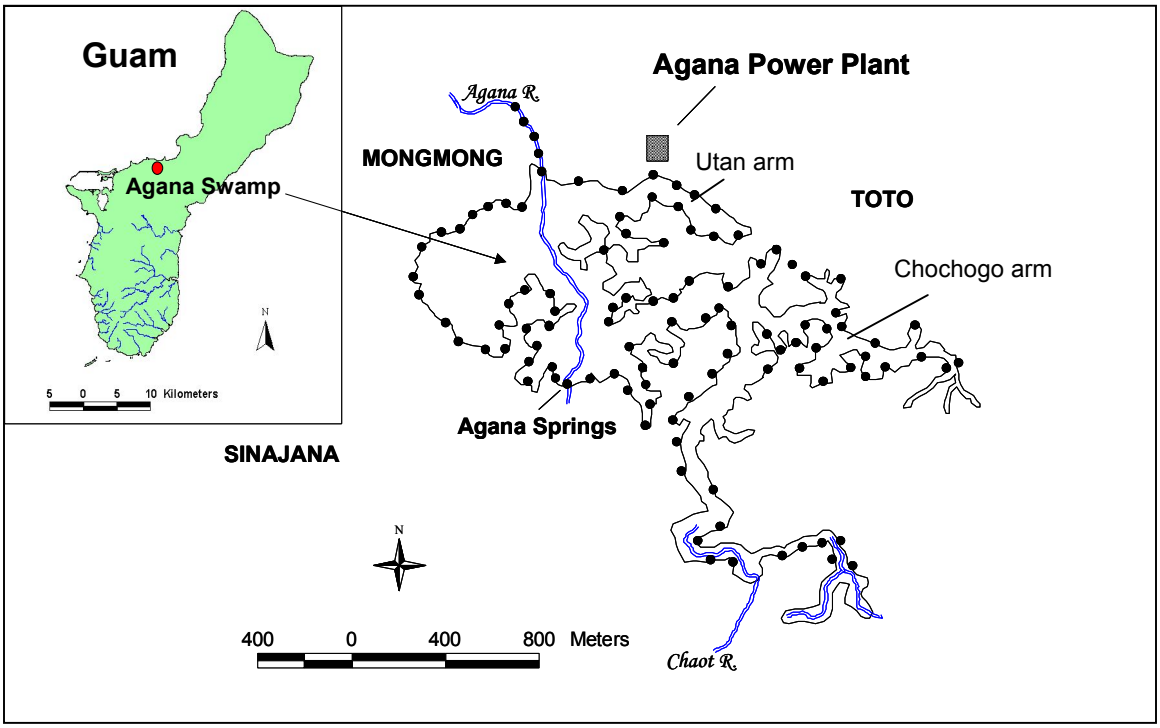

Figure 1. Map of Agana Swamp Showing Location of Perimeter Sampling Sites

Once thawed, each section was thoroughly homogenized in a glass bowl with a polyethylene spatula following the removal of large rocks, shells and other such bulky materials. Samples for heavy metal analyses were placed in acid cleaned polyethylene vials and dried to constant weight at 60^{o}C while those for PCB analyses were air dried in the dark in shallow aluminum pans. Residual amounts of sediment samples were stored in pre-cleaned glass jars at -20^{o}C for further analysis if necessary.

Upon drying, sediments were disaggregated in non-contaminating containers with a heavy Teflon rod. Those samples for metal analysis were sieved through a 1 mm nylon sieve and stored in polyethylene vials at room temperature until required for analysis. Those for PCB analysis were sieved through a 1 mm stainless steel screen into clean glass vials for storage at -20^{o}C.

Appropriate analytical methods for the above contaminants were adapted from the current SW-846 protocols developed by USEPA in addition to those recommended by the NOAA National Status and Trends Program. Appropriate quality control and quality assurance procedures, including full procedural blanks, matrix spikes, and certified reference materials, were built into the analytical procedures.

Principal Findings and Significance
The data summaries for PCBs and other chlorinated pesticides detected in the swamp samples analyzed are presented in Table 1 below. All data are expressed as ng/g dry wt. (ppb). The heavy metal analysis has yet to be completed.

PCBs:
It can be seen that while PCBs were detected in the majority of samples, relatively few samples yielded profiles that matched the commercial PCB mixture, Aroclor 1260. Moreover, no sample exceeded the 1000 ng/g remediation goal recently established by US EPA for PCBs in Agana Swamp.

Soil	Σ_{20}PCBs	Aroclor 1260	DDT	DDE	DDD	Chlordane
Surface (% Quantifiable)	<0.01 - 232 (96)	<0.01 - 511 (26)	<0.1 - 33 (6)	<0.07 - 9.7 (6)	<0.21 - 475 (6)	27 - 687 (3.6)
Subsurface (% Quantifiable)	<0.01 - 640 (86)	<0.01 - 854 (20)	<0.1 - 149 (7)	<0.04 - 52 (7)	<0.1 - 35 (7)	24 - 674 (3.6)

Table 1. PCBs and Chlorinated Pesticides (ng/g) in Agana Swamp Soil

The highest PCB concentrations were found in the Agana Springs area and along the northern perimeter of the swamp into the Utam arm (Fig. 1). The highest overall value (as Σ_{20}PCBs) was 640 ng/g in a subsurface sample collected near the Guam Mass Transit Authority depot. Interestingly, the corresponding surface sample from this site was only 4.3 ng/g suggesting that the overburden at this site had come from elsewhere. Σ_{20}PCB levels were less than 10 ng/g in ~90% of all other surface and subsurface samples taken from within the study area (Fig. 2).

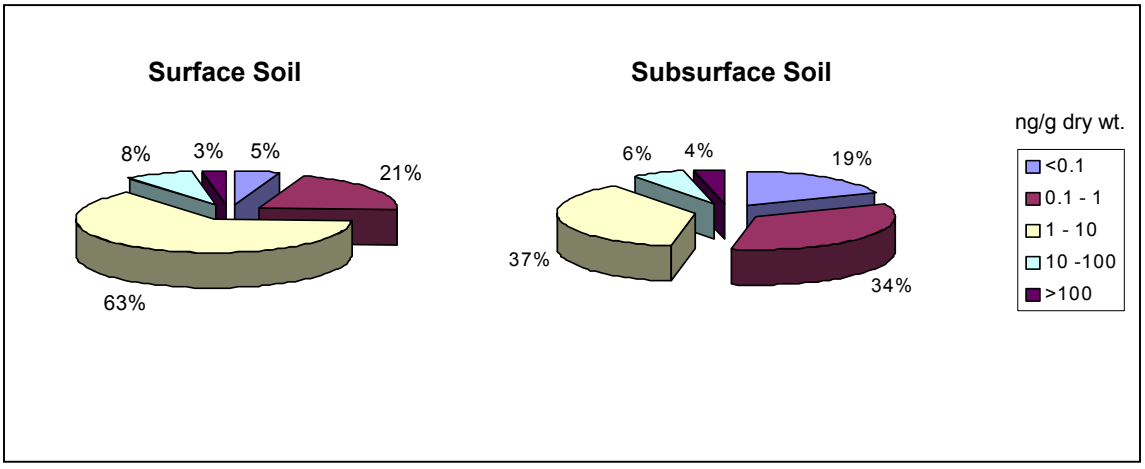

Figure 2. Σ_{20}PCB Concentration Ranges in Agana Swamp Soil

Σ_{20}PCB concentrations were higher in the surface fractions of about two thirds of the soil cores examined. The difference between the two fractions was less than one order of magnitude in the majority of these. Likewise, where Σ_{20}PCB levels were higher in the subsurface fractions, a dissimilarity factor of 10, or less, generally prevailed (Fig. 3).

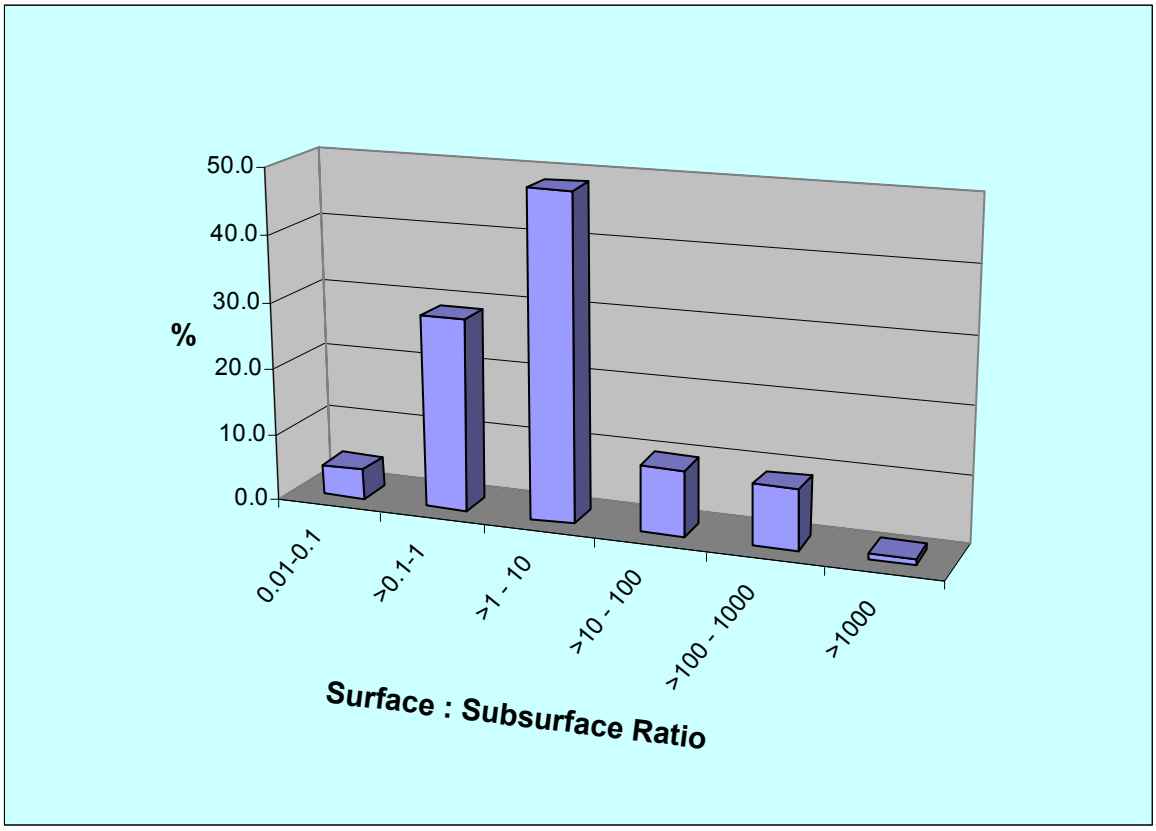

Figure 3. Depth Dependant Differences in PCB Abundance in Agana Swamp Soil

Chlorinated Pesticides:

Of the other chlorinated hydrocarbons looked at, only chlordane and the DDT analogues were occasionally detected (Table 1). In fact, chlordane was only found in a small block of samples adjacent to a commercial shopping center, along the northwestern perimeter of the swamp. In contrast, DDT and related compounds were detected all along the northern edge and into the *Utam* arm of the swamp. Two soil samples from the *Chochogo* arm of the swamp also tested positive for these compounds. The comparatively high concentrations of DDD in several of these samples probably reflect the anaerobic nature of the swamp environment.